R E P O R T R E S U M E S

ED 015 791 24 FS 000 361

EFFECTS OF A STRUCTURED PROGRAM OF PRESCHOOL MATHEMATICS ON COGNITIVE BEHAVIOR.

BY- DEAL, THERRY N.
GEORGIA UNIV., ATHENS, RES. AND DEV. CTR. IN EDUC.

REPORT NUMBER BR-5-0250-RR
CONTRACT OEC-6-10-061
EDRS PRICE MF-$0.50 HC-$2.84 69P.

DESCRIPTORS- *PRESCHOOL CHILDREN, *MATHEMATICS INSTRUCTION, ANALYSIS OF VARIANCE, *EXPERIMENTAL PROGRAMS, *TRAINING TECHNIQUES, TRANSFER OF TRAINING, TASK PERFORMANCE, LEARNING READINESS, *PRESCHOOL LEARNING, NUMBER CONCEPTS, AGE DIFFERENCES, CONCEPT TEACHING, PIAGET,

AN EXPERIMENTAL TRAINING PROGRAM DESIGNED TO TEACH 1 TO 1 CORRESPONDENCE TO PRESCHOOL CHILDREN WAS TESTED TO SEE WHAT EFFECT IT MIGHT HAVE ON THEIR UNDERSTANDING OF NUMBER CONSERVATION. THIRTY-FIVE CHILDREN OF AGES 3, 4, AND 5 WERE RANDOMLY DIVIDED INTO 3 EXPERIMENTAL AND 3 CONTROL GROUPS. THE EXPERIMENTAL GROUPS WERE TRAINED TO PERFORM 1 TO 1 CORRESPONDENCE TASKS IN 8 DAILY HALF-HOUR SESSIONS. THE CONTROL GROUP RECEIVED A GENERAL PRESCHOOL PROGRAM INTENDED TO FACILITATE MATHEMATICAL UNDERSTANDING. A PRETEST INDICATED THAT THERE WAS NO SIGNIFICANT DIFFERENCE BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS. POSTTESTS INDICATED THAT THE EXPERIMENTAL GROUP PERFORMED BETTER ON SPECIFICALLY 1 TO 1 TEST ITEMS, BUT WERE NO BETTER ABLE TO UNDERSTAND NUMBER CONSERVATION THAN BEFORE. AS WAS EXPECTED, THE OLDER CHILDREN PERFORMED SIGNIFICANTLY BETTER THAN THE YOUNGER CHILDREN, BUT THE INCREASE IN MEAN SCORES WAS APPROXIMATELY EQUAL FOR EACH AGE GROUP, INDICATING THAT EVEN THE 3-YEAR-OLDS HAD PROFITED FROM THE TRAINING. TWO EXTENSIVE APPENDICES CONTAIN A DETAILED DESCRIPTION OF THE TRAINING PROGRAM AND THE TEST USED TO EVALUATE CONCEPT UNDERSTANDING. (DR)

BR 5-0250
PA 24

Research Report

EFFECTS OF A STRUCTURED PROGRAM OF PRESCHOOL MATHEMATICS ON COGNITIVE BEHAVIOR

the university of georgia athens, georgia

ED015791
PS 000301

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

EFFECTS OF A STRUCTURED PROGRAM OF PRESCHOOL MATHEMATICS ON COGNITIVE BEHAVIOR

Therry N. Deal

The research reported herein was sponsored by a grant from the Research and Development Center in Educational Stimulation, University of Georgia, under contract #0E-6-10-061 with the U.S. Department of Health, Education, and Welfare, Office of Education, under the provisions of the Cooperative Research Program.

PS 000361

INTRODUCTION

Piaget's work on the development of number concepts has stimulated much recent research interest concerning the effectiveness of training procedures in facilitating the attainment of these concepts. (Churchill, 1958; Ho and Hatano, 1963; Smedslund, 1961; Wohlwill and Lowe, 1962). Most of the training programs have focused on teaching conservation. Success has been achieved in programs most often when the subjects were five years of age or older (Churchill, 1958; Wohlwill, and Lowe, 1962) or where readiness of subjects for attaining conservation had been carefully ascertained (Ho and Hatano, 1963). Zimiles (1965) has recently pointed to the inadequacy of considering conservation a simple unidimensional concept.

In programing for children under five years of age concepts antecedent to conservation should be explored in training programs. Piaget's theory (1952) suggests the concept of one-to-one correspondence as a concept prerequisite to conservation. In the Ho and Hatano (1963) study one of the readiness skills present in children who were successfully taught to conserve was the ability to compare groups of objects for equivalence or non-equivalence.

In this study the operation of placing objects in one-to-one correspondence was conceptualized as a mathematical proof. This

operation enables the individual to make a decision about the attribute of numerosity in collections of discrete objects. A decision can be made regarding equivalence or non-equivalence of groups of objects in terms of numerosity. Placing in one-to-one correspondence is actually a primitive form of counting. It is not necessary to be able to assign number names in order to make a decision that this group has the "same number as", "a number greater than" or "a number less than another group." In counting which is more than rote one knows that each successive number is one more than the previous number named. Counting serves as a short-cut to matching. It is no longer necessary to place in one-to-one correspondence in order to determine if two collections are equivalent. One simply matches by counting. It would be possible to learn to match groups of objects independent of learning to count them.

PURPOSE AND HYPOTHESES

The purpose of this study was to examine the effectiveness of teaching one-to-one correspondence procedures to three, four, and five year old children.

The specific questions asked were these:

1. Does a structured training program designed to teach the concept of one-to-one correspondence result in superior cognitive performance on test items designed to reveal attainment of the concept of one-to-one correspondence

when compared with a general program designed to teach several mathematical concepts concurrently?

2. What is the role of chronological age in the effect of the training procedures on performance?

3. Is there a significant interaction between age and training procedures?

4. Is training in one-to-one correspondence procedures sufficient to promote attainment of conservation?

These questions were stated as research hypotheses.

H_1 The children taught by the structured program will be superior in performance on one-to-one correspondence when compared to those taught by more general procedures.

H_2 In general the older children will attain a higher level of performance than will the younger children.

H_3 The effect of the experimental condition will be greater for the older subjects than for the younger subjects.

H_4 Conservation will not be attained even though the children in the experimental group evidence improved performance on one-to-one matching.

METHODS

Sample

Experimental and control subjects were 3, 4, and 5 year old children, a total of thirty-five subjects, enrolled in the University Nursery School-Kindergarten in Spring, 1966. These children are selected by the preschool so that approximately one-half are children of townspeople and one-half children of University students or teaching personnel.

There were ten 3 year old children; eleven 4 year old children, and fourteen 5 year old children. Random procedures for assignment to groups were followed. There were 5 childrem in the experimental three year old group and 6 children in the two remaining experimental groups. Random procedures produced relatively equivalent sex distribution except in the three year old group where all experimental subject were males and all control females.

Design

The general design of the study was a treatment by levels paradigm. (See figure 1). The levels variate was chronological age. One treatment variate was a set of structured experiences. This experimental training program was designed to teach one-to-one correspondence procedures. The second variate was the set of experiences generally included in the nursery school-kindergarten program to facilitate mathematical understanding in general.

Figure 1

Research Design and Sample Characteristics

Levels Variable	Treatment Variable: Experimental Treatment M	F	Control Treatment M	F	Total numbers of subjects M	F
CA 3-0 to 3-11	5	0	0	5	5	5
CA 4-0 to 4-11	4	2	2	3	6	5
CA 5-0 to 5-11	3	3	4	4	7	7
Total numbers of subjects	17		18		35	

Data Collection

Pre-test data was collected on the two days prior to the beginning of the teaching sessions by a graduate research assistant. During the next eight school days, daily group teaching sessions using the same experimental program with each of the three chronological age levels were conducted. The test examiner collected post-test data on the two days following the training sessions. The teacher and the test examiner were not the same researcher.

The Experimental Training Program

The structured program consisted of playing a game involving the four materials described below.

(1). A hand-loading vending-type machine. The machine accepted round wooden discs and provided a miniature toy for each disc inserted. This machine was approximately 24 inches tall and could be placed on a low table. It had a total capacity of twelve toys all of which could be visible in the plexiglass panel on the front of the machine.*

(2). A series of 3 x 5 cards imprinted with a random placement of black circles, squares, and triangles. The series contained cards with one through twelve objects imprinted. No two cards were exactly alike in arrangement.

*Dr. Joseph R. Hooten designed and constructed the machine to meet the requirements of the research program. His contribution is gratefully acknowledged.

(3). A series of 3 x 5 cards made with the use of stickers representing dogs. The series contained cards with one through twelve dog stickers. No two cards were exactly alike in arrangement and breeds of dogs were mixed on some cards.

(4). A series of 3 x 5 cards with colored abstract symbols. This series also included cards with from one to twelve objects imprinted and no duplicate arrangements.

The eight daily teaching sessions had a similar format. The sessions lasted for approximately 30 minutes. The five or six children in each of the three treatment groups were brought by two aides and the teacher to the experimental room; the teacher remained in the room with the children; the aides left. Only the research materials were displayed in the room to reduce distraction. The teacher was a graduate research assistant in child development. She taught all three sessions daily. Three and five year old groups were taught in the morning; the four year old group in the afternoon. This conformed to the times when the children were in school. A thirty minute break was provided for the teacher between the morning sessions.

The procedure for playing the game was:

1. Demonstration by teacher of important point through the use of the machine, a magnetic board, magnetized cards, and discs.

2. Playing the game in the following order.

   a. Obtain a card from those available for the session.

   b. Match the object(s) on card with wooden tokens.

   c. Exchange the tokens in the machine for a toy.

   d. Check the exchange by matching the toys to the card.

   e. Compare one's collection of toys or discs with others to determine if one had the same number, a number less, or a number more than a peer or teacher.

The circularity of the procedure was seen as the key element in the training procedure. The children did not simply match one group of objects with another, rather, each turn for a child consisted of a series of matches involving change in material and in arrangement of the material.

The order for introduction of number of elements used on any day was carefully controlled. On the first day of the program all the children in the group received a card with the same number and kind of object, one large dot. The emphasis was on equality for all. The children were also served crackers on this day and each child received the same number.

During Days II, III, and IV, the number of elements was steadily increased so that children had experience with group of objects ranging from 3 to 9 in numerosity. The demonstration and discussion by the teacher pointed out that one ignores the attributes of shape and arrangement of objects when making decisions about number of objects.

The children were encouraged to make comparison with the game objects belonging to their peers. The teacher helped them label their comparisons as the "same number as", "a number more than", or "a number less than" some other child's collection.

During Days V and VI the goal was to teach that one can begin matching from any point in the process. It is not necessary to begin with the card. You may begin with the machine and proceed from there. A magnetized bar attached to the plexiglass front of the machine made it possible to match a disc to a toy visible in the machine.

On days VII and VIII, the activities were designed to help the child generalize the matching concept learned through using the machine to other situations. The children hunted and found bags with 3, 8, 12 objects in them. They matched the objects to cards, then compared the number of objects found. In another activity the children looked for sets of pictures on the wall with the same number of dots as those on a card. Finally, the children made up a hunt and find bag. They "proved" whose bag they had found by matching the objects from the bag with each child's card. When card and objects matched they had identified the owner, not by guess but by a "proof."*

Evaluation Devise

Cognitive performance, the dependent variable, was evaluated by a series of test items. Some of the items were similar to those used by Wohlwill (1962). The test items were designed to

*A complete copy of the structured training program outline may be found in Appendix A.

reflect the goals of the training program.

Section A contained eleven items concerned with vocabulary. The aim was to ascertain the labels used by the children for describing non-equivalent groups of items. Very simply, could the child correctly identify and label pictorial presentations of more, most, less, least? The pictorial presentations consisted of 3 x 5 cards on which stickers of dogs were attached or cards on which black circles, squares, and triangles were imprinted. The child was not permitted to handle any materials in responding to these items. All responses had to be made on the basis of his visual appraisal.

Section B of the test consisted of seventeen items presenting equivalent and non-equivalent groups of material. The materials presented were eggs and egg cups; dogs and bones; and bingo chips. In items 12, 16, and 20* the child was asked to perform a matching operation. In the remaining items he was asked to visually survey certain groups of material and reply to one of these questions:

"Are there more eggs or egg cups"; "Are there more dogs or bones"; "Who has more chips, you or I?"

Items 12, 15, 18, 19, 21, 28, 25, 26, and 28 in Section B were conservation items.

Scoring was on a pass and fail basis with 1 point given for each correct response. In some of the items the examiner probed the child for a reply to why he gave the answer which he did.

*See Appendix B for a complete description of all items.

These replies were coded on the scoring sheet as b, c, or d responses but they were not scored. The items were included for the purpose of formulating other hypotheses regarding number concept development and were not analyzed for the purposes of this report.

The twenty-eight item evaluation device was pilot-tested with a group of forty-two children, 14 children at each CA level of 3, 4, and 5 years. These children were in preschools in the same city from which the research sample was drawn. The pilot sample did not include any children who were in the research sample. Analysis of data from the pilot-test sample indicated that the instrument had the following characteristics:

(1). Kuder-Richardson reliability of .84;

(2). Indices of skewness and kurtosis which indicate normality;

(3). Positive point bi-serial correlations for all items with total test score.

On the basis of difficulty level Items 9, 18, 19, 23, 24, 25, 26, and 28 were dropped from the test. Item 12, though a very easy item, was retained because it introduced Section B of the test and provided a success set for the children. Item 14 and 15 were retained in spite of the fact that they were very difficult items for the purpose of testing the hypothesis regarding conservation. Difficulty level of all the items is presented in Appendix C.

The analysis of data for the research study was made on the basis of the twenty items which were selected from the twenty-eight items remaining in the test devise after the pilot study reported above.

RESULTS

The presentation of findings is organized in terms of the hypotheses.

H_1 The children taught by the structured program will be superior in performance on one-to-one correspondence when compared to those taught by more general procedures.

An analysis of variance using pre-test scores indicated that no significant differences existed prior to training between the experimental and control groups. (See Table 1). Since equivalence of groups was indicated by this statistical procedure an analysis of variance was then used to evaluate the post-test results with no further consideration of pre-test data. The pre-test data did indicate a significant difference in scores between age groups which was anticipated.

An examination of the effects of treatment based on post-test scores supports H_1. The difference between treatment groups was significant at the .01 level. (See Table 2).

H_2 In general the older children will attain a higher level of performance than the younger children.

Table 1

Summary of Analysis of Variance from Pre-test Scores

Source	SS	df	MS	F	p
Treatment	.89	1	.89	.15	
Age	205.75	2	102.89	17.79	<.01
T x A	3.92	2	1.96	.33	
Error	167.84	29	5.78		

Table 2

Summary of Analysis of Variance from Post-test Scores

Source	SS	df	MS	F	p
Treatment	35.42	1	35.42	8.31	$<.01$
Age	259.55	2	129.77	30.46	$<.01$
T x A	18.91	2	9.45	2.21	
Error	123.72	29	4.26		

An examination of the analysis of variance for effect of levels (age) supports this hypothesis. This effect is significant at the .01 level. (See Table 2). The total means for each level show an increase of approximately four point which can be observed in Table 3.

H_3 The effect of the experimental condition will be greater for the older subjects than for the younger subjects.

An examination of the interaction between age and treatment failed to reveal any significant difference and this hypothesis is not supported. (See Table 2).

H_4 Conservation will not be attained even though the children in the experimental group evidence improved performance on one-to-one matching.

This hypothesis was contingent upon support for H_1. Since improved performance was evidenced by the experimental group, Item 14 and 15 in the evaluation device were inspected for evidence of attainment of conservation.

Examination of pre-test and post-test scores of the experimental children on Item 14 indicated that only one child passed this item on either pre-testing or post-testing. Examination of scores for Item 15 indicated that no experimental child passed the item prior to treatment and only one child following treatment.

This data, though too limited to be conclusive, supports H_4 as stated.

Table 3

Means of Post-test Scores

Levels	Treatments: Experimental	Control	CA Mean
CA 3	10.00	6.40	8.20
CA 4	13.00	11.80	12.45
CA 5	16.16	13.87	14.85
Aveage Mean	13.23	11.22	

No hypotheses were formulated regarding increments in individual test items scores. However, an analysis of the items in the test indicated that test increases of 10% or more between pre-test and post-test scores occurred for only Items 4, 13, 17 20, and 22. It was in these items that the major effects of treatment were reflected.

DISCUSSION

The results of the study indicated that the structured training program specifically designed to teach the concept of one-to-one correspondence was more effective in doing this than the general program which included a wider variety of mathematical learning experiences. The evaluation device was designed to pick up improvement in one-to one correspondence. It would be erroneous to conclude that the experimental program was superior as a general program of mathematical training. This is another research question and not that question explored in this study. This is an extremely important issue in field rather than laboratory training programs and should be examined in future studies. The test materials for one-to-one correspondence items and training materials were not identical. Some transfer of learning apparently took place since the training program was successful. Greater attention to this aspect of evaluation is needed.

In general, the older children attained higher scores than the younger children. Any other result would have been very surprising

since the pre-test scores indicated the effects of age to be significant. What was not anticipated was the somewhat similar increment in scores which occurred for all age levels. It was anticipated that the older children would show a larger increment. The means reflected a three point increase at each level for the experimental group. This indicates that the three year old subjects in the sample were able to profit from training. The evaluation device will continue to be used in a field center of the Research and Development Center in an effort to discover how soon and under what conditions a ceiling can be reached in these items.

The training procedures were conceptulized by the researcher as a circularity technique. Whether or not this technique was actually an important aspect of the program is a question for further exploration. Some elements of the comparisons between children are similar to Smedsland's (1961) discussion of conflict situations in a training program.

No hypotheses were formulated regarding visual test items versus manipulative items. Of the items where 10% or greater increases occurred, the child was permitted to manipulate the materials only in Item 20. In the other three items, 13, 17, and 22, the child was required to make a visual appraisal and respond. Though the training procedures involved a great deal of manipulation, improvement on Item 13, 17, and 22 suggests that conceptualizing processes were affected.

In Item 4, a 10% increase occurred between pre-test and post-test scores. This was a vocabulary item dealing with the superlative form most. Little improvement in ability to label seems to have occurred. The strong, manipulative appeal of the game materials may have negated the effectiveness of any reward value in the labeling used by the teacher. The rewards were dispensed mainly by the machine and not by the teacher. Where a machine is to be the primary dispenser of rewards one-to-one interaction between machine and pupil may be preferable. In this way the human teacher and the machine-teacher are never competing for attention. However, to have removed the child from the group situation would have deprived him of the opportunity to evaluate his portion of the game in relation to others. Future exploration of this question is needed.

The results of this research indicated that the structured training program was successful. Exactly what elements of the procedure were the most effective portions of the training program is not known and several new research questions have been posed.

REFERENCES

Churchhill, E. M. The number concepts of the young child. Leeds, England, University Institute of Education. Research and Studies, 1958, 18, 34-49.

Ho, Yasuko & Hatano, Gizno. An experimental education of number conservation. Jap. Psychol. Res., 1963, 5 No. 4, 161-170.

Piaget, J. The Child's Conception of Number, London; Routledge and Kegan Paul, 1952.

Smedsland, J. The acquisition of conservation of substance and weight in children. V. Practice in conflict situations without external reinforcement. Scand. J. Psychol., 1961, 2, 153-160.

Wohlwill, J.F. and Lowe, R.C. Experimental analysis of the development of the conservation of number. Child Developm., 1962, 33, 153-167.

Zimiles, H. The Development of Conservation and Differentiation of Number. Monogr. Soc. Res. Child Developm., 1966, Ser.#108, Vol. 31, No. 6.

APPENDICES

A P P E N D I X A

TRAINING PROGRAM OUTLINE

Day I

A. Objectives

1. To establish this teacher, this place, these activities as worthy of the positive approach of the child.

2. To introduce the concept of one object represented by one dot.

3. To introduce the vocabulary concept "same number as" when every child in the group has the SAME NUMBER of objects.

B. Materials

1. "The machine" and 1 toy animal for each child to be dispensed from the machine.

2. Set of cards imprinted with 1 dot. 1 card per child.

3. Tokens (wooden circles) to trade for cards and use in the machine.

4. Magnetic board, 1 magnetized token (wooden circle) and several magnetized cards with 1 dot to be used for demonstration.

5. Name tags with 1 to n stars for matching name tags to tags on chairs. Each child receives different number of stars on tag; a matching tag is on chair without child's name.

6. Crackers, 3 per child, each set having 3 different shapes.

7. Paper plates, 1 per child, for serving crackers.

C. Procedure

1. Introduction

a.) Teacher and 2 observers bring children in, helping them with their name tags. Observers leave.

b.) Help children match name tags to tags on chairs: "We have the same number of chairs as we have people.

c.) Establish purpose for meeting together: "We are going to play games and learn about numbers when we come in here."

2. Game

a.) Demonstrate, using magnetic board. Trade card with one dot for one token to be used in the machine, to obtain one toy.

b.) Emphasize that the toys must remain in the room so they can be used again.

Day I, continued

c.) Play the trading game. Allow children to pick up tokens from a basket. Assist if child takes more than needed. Pass the cards and tokens. "You may have a wooden circle to MATCH the black circle on your card." Allow each child to take a turn at the machine using his one token to obtain 1 toy. Load machine with one toy as each child has his turn.

3. Refreshments

Introduce crackers having different shapes, giving the same number of crackers (3) to each child on a paper plate. "What is different about these crackers?" (The shapes.) "What is the same?" (You all have the same number of crackers.)

Day II

A. Objectives

1. To introduce trading with cards having 1, 2, or 3 dots.

2. To introduce cards with varying geometric objects making up the sets of 2 and 3, emphasizing that regardless of the shape of an object, the number attribute remains the same.

3. To repeat words: MORE, LESS, FEWER, SAME NUMBER AS, A NUMBER THAT IS LARGER, A NUMBER THAT IS SMALLER.

B. Materials

1. The machine and toy animals.

2. Cards

a.) 1 card per child with 2 dots imprinted on it.

b.) 1 card per child with two or three geometric shapes (triangle, square, circle).

c.) Three magnetized cards with two shapes imprinted on each. (Triangle, square, or circle to be used for demonstration).

3. Tokens.

4. Magnetic board and 2 magnetized tokens.

5. Name tags and chair tags.

6. Fences - 1 per child for corralling toy animals (i.e., making a set).

C. Procedure

1. Greeting. Greet children warmly by name. Assist in finding chair using matching of stars as on previous day.

2. Game. Distribute cards with two dots to each child. Allow each child to trade cards for 2 tokens and use them in the machine to obtain 2 toys. Give child a fence after his turn at the machine.

3. Demonstration. Place 3 magnetized cards imprinted with 2 objects of different designs on magnet board. Discuss difference in shape, emphasizing that each card has the <u>SAME NUMBER</u> of shapes. Do not count. Match the 2 magnetized tokens to each card on the magnet board.

4. Game. Place a set of cards face down in front of children, 1 card per child, with varying number (1, 2, 3) and shapes (triangle, square and circle) on each card. Let children draw a card. Match cards with

Day II, continued

tokens. Trade tokens for toy animals from the machine. Match animals to cards. Calling children by name, point out sets of animals that are MORE THAN, LESS THAN, or THE SAME NUMBER AS, another child's set.

Day III

A. Objectives

1. To teach that things can be ARRANGED in many ways and yet contain the same number of objects.

2. To demonstrate the equivalence of several sets.

3. To review the one-to-one match with the number three and to play trading game using the cards the children make.

B. Materials

1. The machine and toy animals.

2. 2 blank magnetized cards.

3. Magnetic board, and 6 magnetized tokens with dogs pasted on top.

4. Magnetic strips to show matching number of dogs on each card.

5. Cards, blank, 1 per child, to be used by children with "lick on" dogs.

6. "Lick on" dogs of different species, 3 per child.

7. Tokens - at least a set of 3 per child.

8. Fences, 1 per child, from previous days.

9. Name and chair tags from previous days.

C. Procedure

1. Demonstration

a.) Put up two blank magnetized cards on board. Put up 3 dogs on each card. "Sets can be ARRANGED in many ways and still have the same number." Move magnetized dogs on a card to demonstrate.

b.) Demonstrate the equivalence of several sets that are arranged differently, using the magnetic rubber strips to connect dogs on cards.

2. Activity

a.) Give each child three "lick on" dogs and a blank card. Let them make cards to use in the game.

b.) Point out the different ways the children arranged the same number of dogs.

3. Game

a.) Let each child trade the card he made for tokens to use in the machine. Give each child a turn.

Day IV

A. Objectives

1. Use terms: MORE THAN, LESS THAN.

2. Continue trading game.

3. Introduce matching on paper.

B. Materials

1. The machine and toy animals.

2. Cards, 1 for each child, imprinted with:

a.) 7 dots

b.) 9 dots

c.) 2 dots

d.) 3 dots

3. Construction paper with lollipops drawn for paper symbolism, 1 per child. Set of stickers per child to match.

4. One set of magnetized cards, imprinted as in B2.

C. Procedure

1. Demonstration

a.) Explain, using magnet board and magnetized strips, that the number of dots on a card is more than or less than the number on another card.

2. Game

a.) Place toys in machine. Allow child to choose the card that he thinks is printed with the same number of dots as there are toys in the machine.

(1) Use 2 or 3 toys, allowing child to decide between cards with 2 or 3 dots.

(2) Use 7 or 9 toys with cards containing 7 or 9 dots.

b.) When child makes choice, say, "You chose the card with: same number, more than, or less than..." (Teacher uses phrase which states accurately what the child's decision was.)

c.) Introduce paper symbolism while children take turns at the machine. Child "matches" symbols by matching a paste-on sticker to "lollipop." (These are materials in B3.)

Day V

A. Objectives

1. To lead toward the concept of matching from memory.

2. To provide children with experience in reversing the trading procedure.

3. To emphasize that difference in appearance does not alter attribute of numerousness.

B. Materials

1. The machine with magnetic strips attached and toys for trading.

2. Cards with 2, 3, 4, 5, 7, 9 dots - at least one per child.

3. Tokens for trading for cards and using in the machine.

4. Magnetized tokens to place on magnetic strip for matching with toys in the machine.

5. Paper plates, 1 per child, plus a demonstration plate for teacher.

6. Facial features (cut from "lick-on" paper: mouth, nose, eyebrows) - 1 set per child plus set for teacher. Each set in envelope for ease in handling.

C. Procedure

1. Demonstration

a.) Demonstrate reversal procedure as follows: Load the machine with toys. Attach tokens to magnetic strips on the machine, so that a token is across from each toy. Find a card that can be matched to the tokens. Remove tokens from machine and match to card as proof. The child is required to "remember" what is in machine if he is to choose correct card. If he "remembers" incorrectly, the tokens will not match card and he can choose another which will match.

2. Game

a.) Load the machine with 2, 3, 4, 5, 7, or 9 toys. Allow child to match tokens to toys and select a card to match with the tokens.

3. Activity: Making faces

a.) Demonstrate making a face on a paper plate, using sample materials from B5 and 6. Emphasize that each child has the SAME NUMBER of facial parts, but they look different.

b.) Hide demonstration face so that it does not serve as a model.

c.) After children make faces, display and talk about them,

Day V, continued

again pointing out the comment in 3a.

d.) Give faces to teacher so children can take home at end of day.

Day VI

A. Objectives

1. To increase the absolute number of objects which children are comparing above a number which can easily be matched by perception alone.

2. To continue the experience in number vocabulary with: MORE THAN, LESS THAN, SAME NUMBER AS.

B. Materials

1. Machine and toys for trading.

2. Cards with five and seven geometric shapes, 1 each per child.

3. Tokens.

4. Magnetized strips for matching tokens with toys in machine as on Day V.

C. Procedure

1. Introduction. Explain that the cards being used have different shapes on them. Some cards have more shapes, some have less.

2. Game. Play the game with cards imprinted with 5 and 7 shapes.

3. Repeat: MORE THAN, SAME NUMBER AS, LESS THAN, as children play trading game.

4. Leave the children's cards in front of them. After they have used tokens and obtained toys, load the machine with one child's toys. Ask another child to pick a card which will help him get the toys. Continue this until all children have a turn. Allow child to match the shapes on the card with toys in the machine. Sometimes a child's decision will be wrong; sometimes correct. Say, "You chose a card (with more than, less than, or the same number as) X X X 's toys which were in the machine.

Day VII

A. Objectives

1. To encourage use of memory for attribute of numerousness.

2. To permit aid to memory when memory fails.

3. To attempt to aid in generalizing the concept of one-to-one matching with "look for" sets.

B. Materials

1. Machine and toys for trading.

2. Pairs of cards with 4 and 6 geometric shapes: 1 pair per child.

3. Tokens

4. One paper bag per child filled with either, 3, 8, or 12 toys.

5. Cards with 3, 8, or 12 differently shaped and colored objects, at least 2 cards per child.

C. Procedure

1. Introduction. Load machine with 4 toys. Children are instructed to look at the number of toys in the machine and to find 2 cards which have the same number of shapes as there are toys, choosing cards from either of two piles containing cards imprinted with 4 and 6 shapes.

2. Matching. Child obtains tokens from the basket. He matches the cards with the same set of tokens to see if both cards he has selected have the same number of shapes.

3. Game. Play the game with the tokens. Children are instructed to "see if they get all of the toys with no tokens left over."

4. Play a "look for" game. Tell children that bags are hidden which contain different numbers of things. Let each child find 1 bag. Compare and match the toys in the bags with cards having 3, 8, or 12 differently shaped and colored objects. Talk about the SAME NUMBER AS, A NUMBER MORE THAN, A NUMBER LESS THAN.

Day VIII

A. Objectives

1. To continue use of memory for attribute of numerousness.

2. To continue "discovery of sets."

3. To use paper symbols for matching.

B. Materials.

1. One paper bag per child.

2. Toys, a different number for each bag (3, 5, 6, 7, 9, 12).

3. Cards with 3, 5, 6, 7, 9, and 12 shapes.

4. A set of pictures pasted on construction paper; 1 set of 1, 1 set of 2, etc.

5. A set of cards with 1 - 12 dots imprinted on them.

6. Tokens for matching cards to picture sets.

C. Procedure

1. Give each child a card from B3, and a bag. Tell him to put "that many" toys in the bag. Children match toys to card, then fill the bag.

2. The teacher hides the bags.

3. Let children find the bags.

4. Help children to remember whose bag each found by matching the number of objects in the bag with the child's card.

5. Give each child a card with any number of dots, 1 - 12. Have him find the set of pictures on the construction paper that can be matched in one-to-one correspondence with the dots on his card. Bring picture to table. Use tokens to check the match by placing first on child's card, then transferring to the pictures pasted on the paper.

A P P E N D I X B

EVALUATION DEVISE

Introduction

Establish rapport between examiner and subject.

Small conversation: (examples)

"Hello, _____, how are you today?"

That's a pretty blue shirt you're wearing today.

I need your help today _____, put your finger on the card, etc.

Randomly:

"My, you're doing a good job for me, _____."

"You're really helping me a lot today,_____."

1. Place 2 cards on table. (leave small space between them)

1 card with 12 objects (right)

1 card with 5 objects (left) (dogs) - different kinds of dogs

Scoring:

a. Score 1 for indicating the card with 12 objects. (perceptual)

(Q) Put your finge on the card that has <u>more</u> dogs.

2. Lay out three cards on table.

(Leave a small space between them) geometric items

1 card with 12 objects — Middle

1 card with 5 objects — Left

1 card with 2 objects — Right *

Scoring:

Score 1 for indicating the card with 12 objects (perceptual).

a. (Q) Put your finger on the card that has the most black things.

Indicate Left, Middle, Right on back of cards to show placement on table.

* Placement instructions refer to examiner's right or left.

3. Place two cards on table.

(leave small space between them) geometric

1 card with 5 objects (Right)

1 card with 6 objects (Left)

(Q) Put your finger on the card that has more black things.

a. Score 1 for indicating card with 6 objects.

(Q) How do you know that card has more black things?

Score 1 for either b, c, or d.

If S answers "I just knew" or similar answer--E may ask more questions to establish evidence of numerical comprehension.

Example:

S - "I counted them."

E - "And how many did you count on each card?"

b. Gives any verbal explanation. (I just knew," or "I don't know" would not be an explanation).

c. Gives explanation which includes evidence of matching.

d. Gives explanation which gives evidence of counting.

4. Lay out three cards on table.

(leave a small space between them)

1 card with 5 objects right

1 card with 6 objects middle

1 card with 7 objects left

(Q) Which card has the most? dogs?

a. Score 1 for indicating the card with 7 objects.

(Q) How do you know?

Three levels of score-See #3. Write out examples of answers.

b. Gives any verbal explanation. ("I just knew," or "I don't know" would not be explanation).

c. Gives explanation which includes evidence of <u>matching</u>.

d. Gives explanation which gives evidence of <u>counting</u>.

Number cards on back to show placement on table, i.e. Left, Middle, Right.

5. Place two cards on table.

(leave a small space between them)

1 card with 12 objects right

1 card with 5 objects left

(Q) Which card has <u>less</u>? black things?

a. Score 1 for indicating card with 5 objects.

6. Lay out three cards (leave a small space between them).

1 card with 12 objects right

1 card with 5 objects middle

1 card with 2 objects left

(Q) Which card has the least? Black things?

a. Score 1 for indicating the card with 2 objects.

Indicate placement on back of cards, i.e. Left, Middle, Right.

7. Place two cards on table. (leave small space between them)

1 card with 5 objects right

1 card with 6 objects left

(Q) which card has less? dogs?

a. Score 1 for indicating card with 5 objects.

(Q) How do you know?

Three levels of score - see sheet #3.

b. gives any verbal explanation. (I just knew," or "I don't know" would not be an explanation).

c. Gives explanation which includes evidence of <u>matching</u>.

d. Gives explanation which gives evidence of <u>counting</u>.

8. Lay out three cards on table. (leave small space between them) (same kind of objects)

1 card with 5 objects left

1 card with 6 objects right

1 card with 7 objects middle

(Q) Which card has the least number of dogs on it?

a. Score 1 for indicating the card with 5 objects.

(Q) How do you know?

Three levels of score - see #3.

b. Gives any verbal explanation. ("I just knew," or "I don't know" would not be an explanation).

c. Gives explanation which includes evidence of <u>matching</u>.

d. Gives explanation which gives evidence of <u>counting</u>.

Indicate Left, Middle, Right on back of cards to show placement on table.

Place two cards on table. (leave small space between them)

1 card with a square on it right

1 card with a circle on it left

(Q) Point to the card that has a black circle on it. Start with this because most children know "circle" and therefore it gives them confidence.

a. score 1 for correct answer.

10. Place two cards on table. (leave small space between them)

1 card with a circle on it right

1 card with a triangle on it left

(Q) Point to the card that has a black triangle on it. (If knew circle before - then should know triangle here).

a. Score 1 for correct answer.

11. Place two cards on table.

(leave small space between them)

1 card with a square on it left

1 card with a triangle on it right

(Q) point to the card that had a blacksare on it.

a. Score 1 for correct answer.

12. Put 7 egg cups on table.

Give S a basket or box of 14 eggs (plastic)

Direction: Put in here (indicating egg cups)

as many eggs as there are (cups, places, holes?)

a. Score 1 for placing 7 eggs in the egg cups. (leave space on score sheet for comment, ex.: Parallel row; groups; counted;)

13. Place plastic strip, on which is glued 7 eggs, on table. Lay out 7 egg cups parallel to egg, so that both rows are the same length and with the eggs and egg cups opposite each other.

(Q) Are there more eggs or more egg cups?

a. Score 1 for indicating equivalence.

(Q) How do you know?

Score 3 levels as in #3.

b. 1 for verbal explanation

c. 1 for explanation which includes evidence of matching.

d. 1 for explanation which includes evidence of counting. If answer is incorrect, E matches eggs & egg cups to show equivalence. After this, S is told, "See, there are the same number of eggs as there are cups."

14. The row of 7 eggs and the parallel row of 7 egg cups are already on the table. Extend the row of egg cups in both directions in a length twice the length of the eggs.

(Q) Are there more eggs or more egg cups?

a. Score 1 for indicating equivalence.

15. The row of 7 eggs and the parallel row of 7 egg cups are already on the table.

Subdivide the row of egg cups into two rows of 4 and 3 cups, and place parallel to the row of eggs.

(Q) Are there more eggs or more egg cups?

a. Score 1 for indicating equivalence

0 for not indicating equivalence.

16. Put down a row of 7 dogs.

Place a box containing 14 bones near S.

Direction: "Put down just as many bones here (indicating an imaginary row paralleling the row of dogs), as there are dogs."

a. Score 1 for putting down 7 bones.

Remove items from table.

Comment: Parallel row

Counted

Groups

17. Place a row of 7 dogs bones, parallel to each other, so that both rows are the same length, and with dogs and bones opposite each other. (bones are closer to S).

(Q) Are there more dogs or more bones?

a. Score 1 for correct response.

Three levels of score - see #3.

b. Gives any verbal explanation. ("I just knew," or "I don't know" would not be an explanation).

c. Gives explanation which includes evidence of matching.

d. Gives explanation which gives evidence of counting.

(Q) How do you know?

(This question is asked regardless if above answer is correct or incorrect.) S should be made to realize that both rows have the same number of items. E can match objects and (if necessary) say outright, "So there are the same number of dogs as there are bones, aren't there?"

18. The row of 7 dogs and the parallel row of 7 bones are on the table. (As in number 17). Extend the row of dogs in both directions to a length about twice the length of the row of bones.

(Q) Are there more dogs or more bones?

(Or are both rows the same)

a. Score 1 for indicating that both rows are equal; same both have same number, etc.

19. The row of 7 dogs and parallel row of bones are on the table.

Subdivide the row of dogs into two rows of 4 and 3 dogs, and place parallel to the row of bones.

X X X X X X X bones
O O O O
O O O dogs

(Q) Are there more dogs or more bones?

a. Score 1 for indicating that both rows have the same number.

20. Lay out a row of 7 chips on the table.

Give S an envelope containing 14 chips.

Direction: "Put down just as many of your chips over here (indicating an imaginary row paralleling E's row), as I have here."

a. Score 1 for putting down 7 chips.

Remove chips from table.

21. Number vs. Length

Lay out a row of 7 chips extending beyond the limits of E's row of 7 chips (S's row is now longer than E's.

(7 E's) .....

(6 S's) . . . . . .

(Q) Who has more chips, you or I?

a. Score 1 for answer E has.

(Q) How do you know?

See # 3 score

b. Gives any verbal explanation.

c. Gives explanation which includes evidence of matching.

d. Gives explanation which gives evidence of counting.

Remove chips from table.

22. Place paper strip, on which is glued 7 chips, in front of S. Lay down another row of 7 chips, parallel to the glued row, so that both rows are of the same length, and the chips in one row are directly opposite those in the other.

(Glued row is closer to S.)

(Q) Who has more chips, you or I/

a. Score 1 - indicating equivalence.

(Q) How do you know?

Three levels of scores.

b. Gives any verbal explanation.

c. Gives explanation which includes evidence of <u>matching</u>.

d. Gives explanation which gives evidence of <u>counting</u>.

Try pieces glued on plastic.

Glued chips belong to S.

23. The row of glued chips and parallel row of loose chips are already on the table. (Glued chips belong to S)

Extend the row in both directions to a length about twice that of the glued row. (See #16).

(Q) Who has more chips, you or I?

a. Score 1 for indicating both rows have the same amount of chips.

24. Subdivide the E's row (loose chips) into two rows of 4 and 3 chips, and place parallel to the S row. (See # 16).

(Q) Who has more chips, you or I?

a. Score 1 for indicating rows are equivalent.

25. Place E's 7 loose chips in a vertical pile in front of S's row of glued chips.

(Q) Who has more chips, you or I?

a. Score 1 for indicating rows are equivalent.

26. Insert E's 7 loose chips into an opaque tube. Hold tube in front of S's 7 glued chips.

(Q) Who has more chips, you or I?

a. Score 1 for indicating rows are equivalent.

(Opaque tube simply made from a sheet of paper rolled and taped.)

27. Place two rows of 12 chips each, one glued and the other loose, parallel to each other so that both rows are of the same length, and the chips in one row are directly opposite those in the other. (Glued row is closer to S).

(Q) Who has more chips, you or I?

a. Score 1 for indicating rows are equivalent.

(Q) How do you know?

Three levels of scoring - see #3.

b. Gives any verbal explanation.

c. Gives explanation which includes evidence of <u>matching</u>.

d. Gives explanation which gives evidence of <u>counting</u>.

28. Place two rows of 12 chips each, one glued and the other loose, parallel to each other so that both rows are of the same length, and the chips on one row are diredtly opposite those in the other. (Blue row closer to S)
Extend the red row in both directions to a length about twice that of the blue row.

(Q) Who has more chips, you or I?

a. Score 1 for indicating rows are equivalent.

Name:

Age:

Birth Date:

Examiner:

Item	0	1
1a.		
2a.		
3a		
b.		
c.		
d.		
4a.		
b.		
c.		
d.		
5a.		
6a.		
7a.		
b.		
c.		
d.		
8a.		
b.		
c.		
d.		
9a.		
10a.		
11a.		
12a.		
13a.		
b.		
c.		
d.		
14a.		
15a.		
16a.		
17a.		
b.		
c.		
d.		
18a.		
19a.		
20a.		
21a.		
b.		
c.		
d.		
22a.		
b.		
c.		
d.		
23a.		
24a.		
25a.		
26a.		
27a.		
b.		
c.		
d.		
28a.		
TOTAL		

Voc. Total_____

(Items 1 - 11)

Section A - Vocabulary
Items 1 - 11

Section B - One-to-one
correspondence
and conservation

Item 12 - 28

A P P E N D I X C

DIFFICULTY LEVEL OF ITEMS IN EVALUATION DEVISE

DIFFICULTY LEVEL OF ITEMS IN THE EVALUATION DEVISE

Percentages indicate proportion of children who passed the item.

1. .83
2. .79
3. .62
4. .71
5. .17
6. .19
7. .29
8. .14
9. .93 Dropped. Item was too easy.
10. .83
11. .81
12. .98 Retained as a success item
13. .31
14. .02 Retained in order to test hypothesis regarding conservation
15. .05 Retained in order to test hypothesis regarding conservation
16. .83
17. .21
18. .02 Dropped. Too difficult
19. .02 Dropped. Too difficult
20. .45
21. .06
22. .43
23. .00 Dropped. Too difficult
24. .00 Dropped. Too difficult
25. .00 Dropped. Too difficult
26. .02 Dropped. Too difficult
27. .43
28. .00 Dropped. Too difficult.